

Available online at www.sciencedirect.com

SciVerse ScienceDirect

journal homepage: www.e-jds.com

CASE REPORT

Screw hole-positioning guide and plate-positioning guide: A novel method to assist mandibular reconstruction

Tong-Mei Wang^{a,b}, Hao-Hueng Chang^{a,c}, Yi Ho^{a,b}, Li-Deh Lin^{a,b*}

^a School of Dentistry, National Taiwan University, Taipei, Taiwan

^b Division of Prosthetic Dentistry, Department of Dentistry, National Taiwan University Hospital, National Taiwan University, Taipei, Taiwan

^c Division of Oral and Maxillofacial Surgery, Department of Dentistry, National Taiwan University Hospital, National Taiwan University, Taipei, Taiwan

Final revision received 17 February 2012; accepted 29 May 2012

Available online 10 July 2012

KEYWORDS

mandible;
reconstruction plate;
stereolithography;
surgical stent

Abstract Reconstruction plates have been used to bridge discontinuity defects after resection of mandibular tumors for many years. However, shaping and adapting the titanium plate during surgery is time consuming and technique sensitive especially for a large defect or a disease-deformed mandible. In this case report, a method is introduced to assist surgeons in pre-shaping a reconstruction plate before surgery, and with the aid of a position guide and drilling guide, the pre-surgically adapted reconstruction plates can be positioned at the planned position during surgery. This method improves surgical outcomes and decreases operating time.

Copyright © 2012, Association for Dental Sciences of the Republic of China. Published by Elsevier Taiwan LLC. All rights reserved.

Introduction

Reconstruction plates have been used to bridge discontinuity defects after resection of mandibular tumors for

many years.^{1,2} However, contouring and adapting the titanium plate during surgery are both time consuming and technique sensitive if the resection area is large or the tumor has deformed the mandible.^{3,4} An anatomical model created with computed tomography (CT) and stereolithography (STL) can assist surgeons in establishing a practical reconstruction plan and preoperatively contouring the reconstruction plate.^{5,6} For cases without a deformed mandible, the surgeon usually places the pre-adapted plate and drills the fixation screw holes on the healthy

* Corresponding author. Department of Dentistry, National Taiwan University Hospital, National Taiwan University, 1 Chang-Te St, Taipei 106, Taiwan.

E-mail address: lidehlin@ntu.edu.tw (L.-D. Lin).

mandibular segments before the resection.^{1,2} For cases with a deformed mandible, the pre-adapted plate is difficult to place accurately before resection of the tumor and at the planned position after resection. Several external fixation techniques have been used to stabilize the proximal mandibular segments during reconstruction.^{2,7-9} Nonetheless, special devices are needed, and it is impossible to rearrange the proximal segments to a normal contour if the mandible is already deformed or fractured because of disease. To overcome these problems, this report presents a technique that can accurately transfer the planned locations of fixation screws and accurately position the pre-adapted plate during mandibular reconstruction.

Case report

Patient history

A 44-year-old female patient had been suffering from an osteosarcoma in the left mandibular molar area since

October 2001. A left marginal mandibulectomy and upper-neck dissection were performed, and no advanced radiotherapy was assigned after the surgery, but a fracture was noted at the left mandibular angle 3 months after the operation. Mandibular continuity was restored several times, but was in vain because of infection and skin perforation. Finally, the defect was left alone, and all reconstruction plates and grafts were removed to allow complete healing. After 6 months, the soft tissue had healed, and no further infective signs were noted. Nevertheless, medial rotation of the disconnected mandibular segments and a retrognathic profile were noted (Fig. 1). An operation was planned to reconstruct the mandible with a free osteocutaneous fibular graft. Because of the asymmetrical facial profile and deformed mandibular contour, a special procedure was designed to rebuild the patient's appearance.

Laboratory procedures

Prior to surgery, an STL model including the maxilla and mandible was created with the CT data by means of an STL

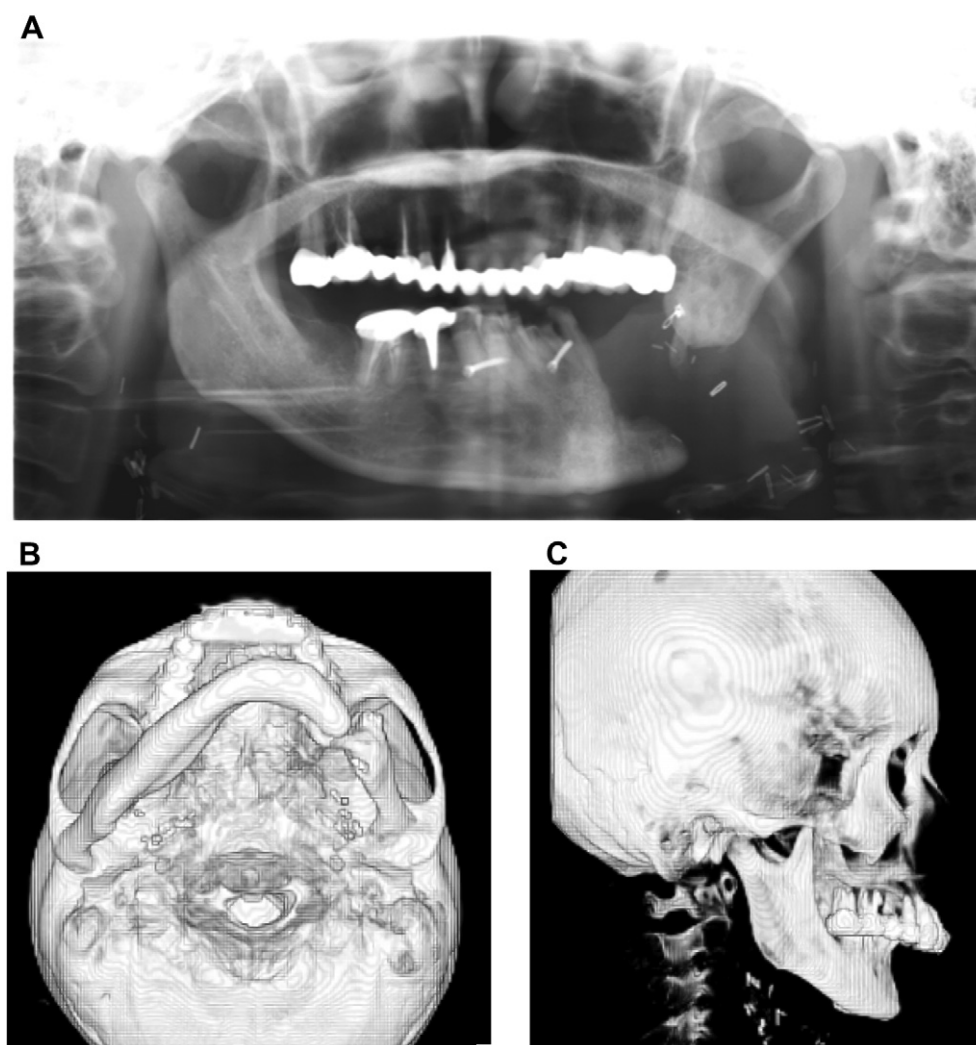


Figure 1 (A) Panoramic radiograph; (B) reconstructed CT image showing disconnected and medially deviated proximal segments of mandible; (C) reconstructed CT image showing retrognathic profile.

rapid prototyping technique (Fig. 2A). Using the maxillary teeth and bilateral condylar fossae as references, the disconnected segments of the mandibular model were repositioned as appropriate to form a symmetrical mandibular arch and harmonized occlusion of the remaining teeth. Paraffin wax was used to fill in the gap between the two segments to achieve an ideal contour of the mandible (Fig. 2B). A titanium reconstruction plate (BMR, Mondeal Medical Systems, Tuttlingen Germany) was bent and adapted to the buccal surface of the restored mandible STL model (Fig. 3A). A plate-positioning guide (PPG) and a screw hole-positioning guide (SHPG) were prepared to transfer accurately the spatial relation between the adapted reconstruction plate and restored proximal segments from the model to the patient during the operation (Fig. 3A). The PPG was a clear acrylic resin block

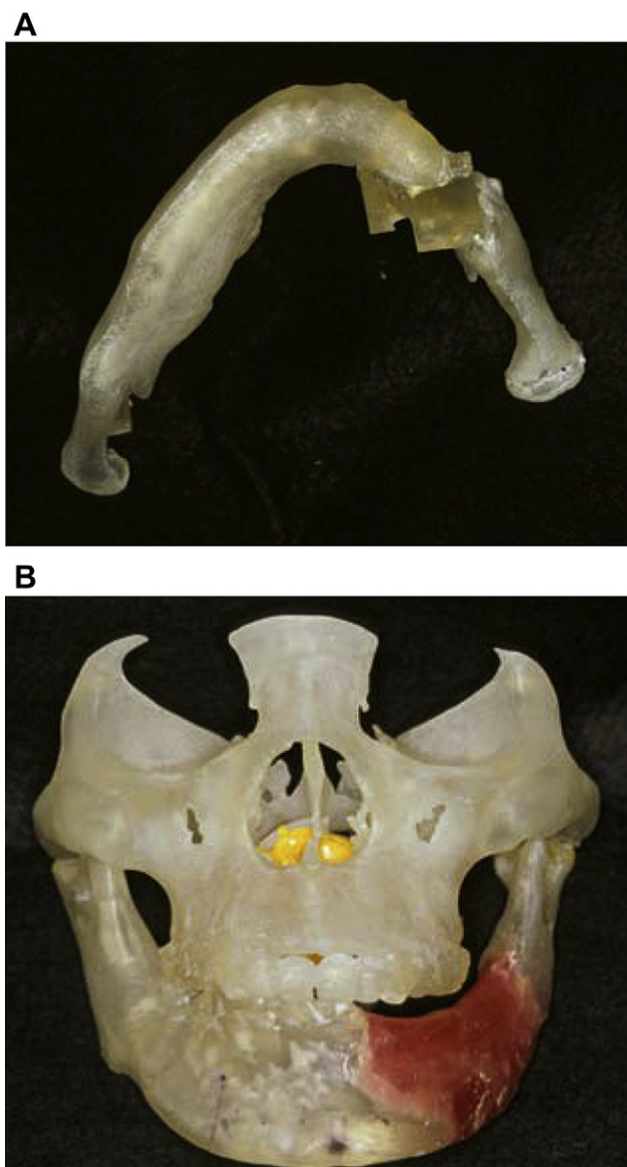


Figure 2 (A) An STL model fabricated based on CT data; (B) the corrected mandibular model with paraffin wax filling the gap between proximal segments.

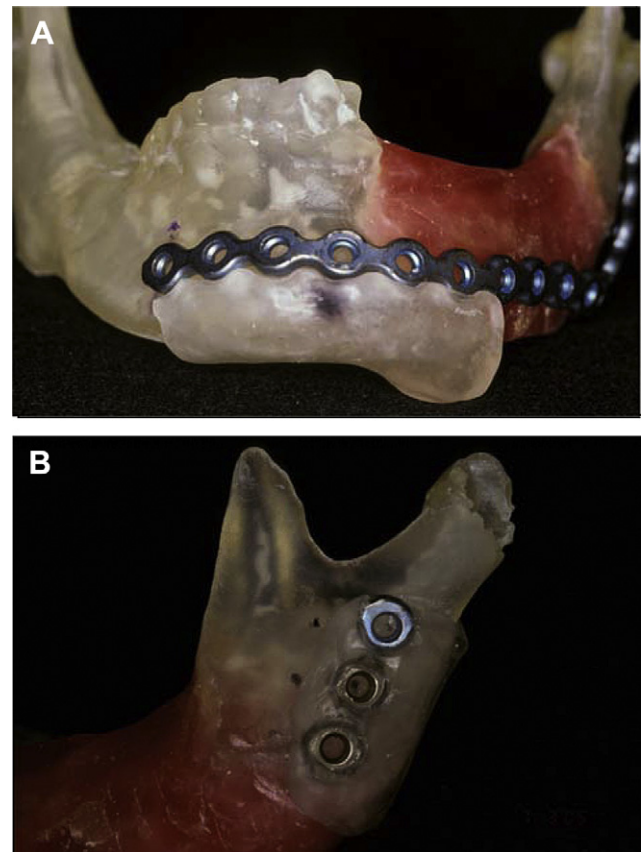


Figure 3 (A) The resin PPG and the pre-adapted plate fitted into each other and on the STL model; (B) the SHPG made of pieces of titanium rings and resin block fitting on the STL model.

adapted to the lower border of the reconstruction plate and the buccal surface of the STL model at the symphyseal area (Fig. 3A). The resin block also extended to the lower border of STL mandibular model, and the thickness was at least 2 mm to achieve adequate rigidity. The SHPG was fabricated for the left ramus segment. It included three small titanium rings embedded in the resin block which indicated the positions of the screw holes, as those planned on the model, during surgery (Fig. 3B). These rings can guide the drill to make correct screw holes and assemble the reconstruction plate and segment as planned. The resin block also covered the buccal surface and extended to the posterior border of the model for adequate stability.

Repositioning of the mandibular segments during the operation

After resection of the tumor, the surgeon first placed and checked the adaptation of the PPG on the right mandibular segment and then the pre-adapted plate according to the index on the PPG. The PPG-plate assembly was used to guide the surgeon to drill screw holes at the planned positions. Then the surgeon placed and adapted the SHPG on the left segment of the mandible and drilled the screw holes through the titanium rings. Because the positions of the screw holes on the two segments were the same as

those on the STL model, the pre-adapted plate could be fixed on the mandibular segments and the mandibular continuity reestablished as planned. After this procedure, the free fibular graft was fixed to the reconstruction plate to fill in the bony defect (Fig. 4B).

Postoperative outcomes and treatments

The CT images after the operation showed a symmetrical mandibular arch with improved intermaxillary jaw

relationships using this special technique (Fig. 4A). Nine months after the reconstruction surgery, four dental implants (Brånemark TiUnite, Nobel Biocare AB, Gothenburg, Sweden) were placed into the bone graft. A hybrid fixed partial denture was fabricated later (Fig. 4C). A panoramic radiograph demonstrated that no obvious bone resorption had occurred either in the peri-implant area or at the junction between the bone graft and native mandible at 17 months of follow-up (Fig. 4C).

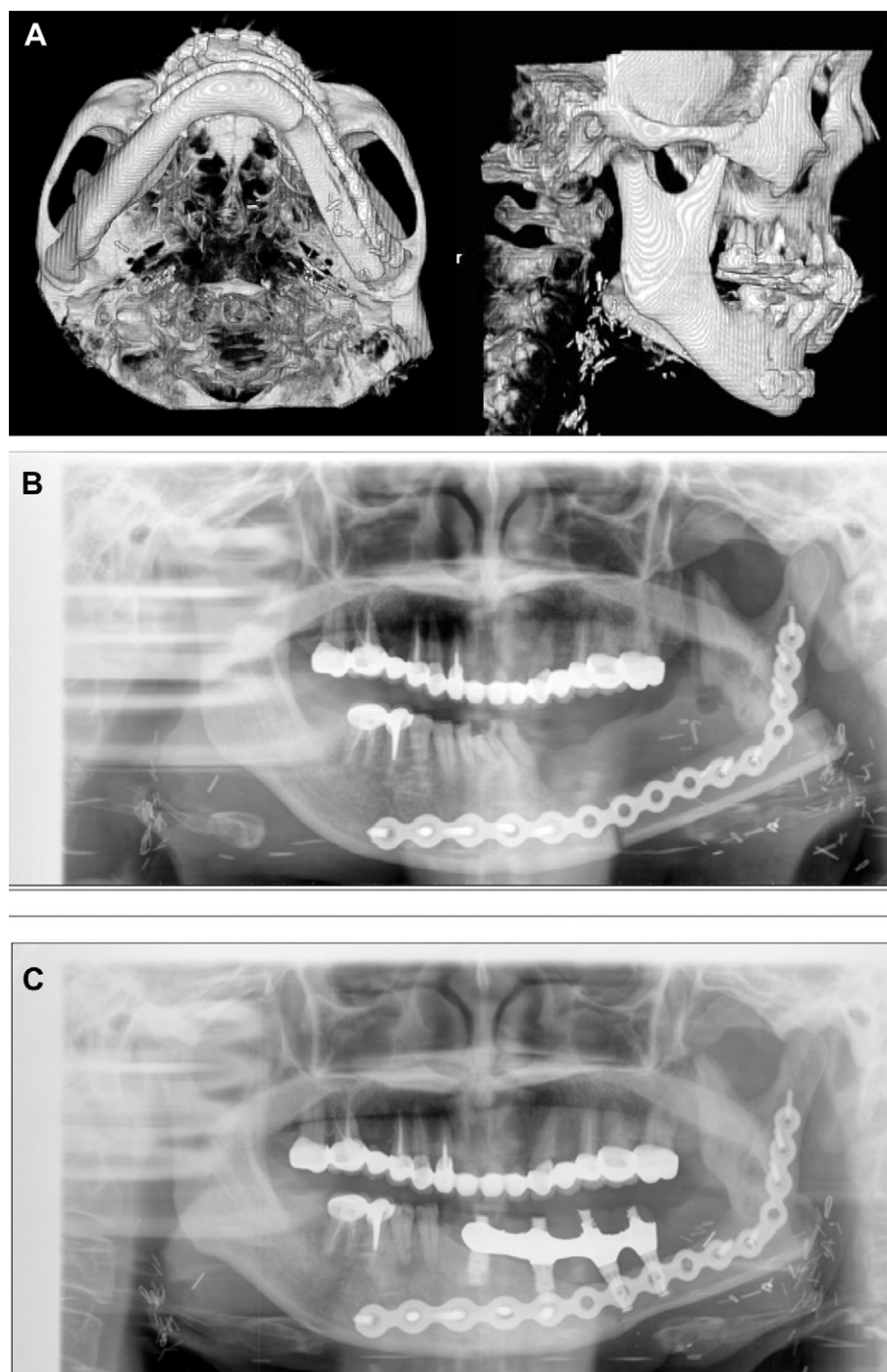


Figure 4 (A) The reconstructed CT image after operation showing a symmetric arch (left) and favorable jaw relationship (right); (B) panoramic radiograph after the reconstructive surgery; (C) panoramic radiograph after 17 months of follow-up.

Discussion

Mandibular defects after segmental resection usually cause esthetic deformities and functional losses. For large defects or edentulous patients, using an STL model to form a pre-adapted reconstruction plate is suggested.^{3,5} There are still challenges during reconstruction surgery including keeping the three-dimensional relationships of two separated proximal segments and the reconstruction plate as planned after tumor resection. It is difficult to fix the pre-adapted plate, before mandibular resection, on the mandible that has been distorted owing to an exophytic or perforated lesion. Several temporary intraoperative external fixation devices were introduced to solve this problem.^{2,7–9} Those techniques do not interfere with the outline of the mandible and can successfully maintain the preoperative spatial relation of proximal segments. Nevertheless, they could not be applied in our case because the original contour and continuity of the mandible had been lost. The corrected STL model and SHPG/PPG techniques introduced here provided a chance to correct dis-oriented segments to normal positions. Accurately locating the fixation screw holes offers the advantage of stabilizing the proximal segments in the original or planned relationship on the STL model. In addition, the SHPG and PPG do not need wider or additional operative fields, as do external fixation devices. Both the SHPG and PPG can accurately guide the drilling of fixation screw holes, but using the PPG is difficult in the small ramus segment since it is difficult to hold the small segment, PPG, and reconstruction plate together at the same time for screw hole drilling.

Microvascular reconstruction with osseous free tissue transfer has become the preferred technique for mandibular defects.⁴ The combined use of the reconstruction plate can maintain the rigid three-dimensional relationship between bone segments during the healing period. Compared to miniplates, the reconstruction plate can be used as a template for shaping the bone graft and can thus decrease operating time.

The use of osseointegrated implants has improved dental rehabilitation in cases reconstructed with a vascularized flap.¹⁰ Therefore, reconstructing a missing segment of the mandible with a high degree of anatomic precision is the key to avoiding facial asymmetry and an unfavorable mandibular arch form which might prevent the proper positioning of dental implants. The corrected STL model can be designed on the computer and made with CAD/CAM techniques using a mirror image of the normal side to form

a symmetrical mandible.⁵ However, special software and training are required to become familiar with this technique. In our experience, surgeons prefer actual models, and real models are also a convenient tool for surgical planning and communication with patients. In our case, the pre-adapted reconstruction plate, SHPG, and PPG were fabricated manually. In the future, special software may be available to design and mill the customized pre-adapted plate and fabricate the SHPG or PPG by CAD/CAM techniques just like surgical guide stents for implantation.

In conclusion, it is helpful to use the STL model to analyze and plan mandibular reconstruction surgery. The technique of a screw hole-positioning guide and plate-position guide can assist surgeons in accurately placing a pre-adapted reconstruction plate at the planned position.

References

1. Blackwell KE, Lacombe V. The bridging lateral mandibular reconstruction plate revisited. *Arch Otolaryngol Head Neck Surg* 1999;125:988–93.
2. Marchetti C, Bianchi A, Mazzoni S, Cipriani R, Campobassi A. Oromandibular reconstruction using a fibula osteocutaneous free flap: four different "preplating" techniques. *Plast Reconstr Surg* 2006;118:643–51.
3. Vural E, Yuen JC. Combining use of resin models with external fixation in mandibular reconstruction. *Arch Otolaryngol Head Neck Surg* 2007;133:603–7.
4. Mehta RP, Deschler DG. Mandibular reconstruction in 2004: an analysis of different techniques. *Curr Opin Otolaryngol Head Neck Surg* 2004;12:288–93.
5. Hannen EJ. Recreating the original contour in tumor deformed mandibles for plate adapting. *Int J Oral Maxillofac Surg* 2006;35:183–5.
6. Ueda K, Tajima S, Oba S, Omiya Y, Byun SI, Okada M. Mandibular contour reconstruction with three-dimensional computer-assisted models. *Ann Plast Surg* 2001;46:387–93.
7. Ung F, Rocco JW, Deschler DG. Temporary intraoperative external fixation in mandibular reconstruction. *Laryngoscope* 2002;112:1569–73.
8. Ameerally PJ, Hollows P. Use of an external fixator to stabilise the proximal mandibular segments during reconstruction. *Br J Oral Maxillofac Surg* 2004;42:354–6.
9. Iwai S, Moriyama T, Amekawa S, Katagiri W, Nakazawa M, Yura Y. A modified repositioning system for segmental resection of the mandible. *Int J Oral Maxillofac Surg* 2006;35:270–3.
10. Roumanas ED, Markowitz BL, Lorant JA, Calcaterra TC, Jones NF, Beumer 3rd J. Reconstructed mandibular defects: fibula free flaps and osseointegrated implants. *Plast Reconstr Surg* 1997;99:356–65.